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ABSTRACT

A study examined gender and student group differences in stereotypes and confidence for first-year and more advanced computer science (CS) students. In the spring of 2001, 18-page questionnaires were distributed to first-year students (n=30: 21 females, 9 males) and students enrolled in an introductory CS course (n=32: 11 females, 21 males) designed for students considering majoring in CS. Findings showed no gender difference in computer confidence for first-year students, but females in CS had significantly lower confidence than did males. (Contains 27 references.) (Author/BT)

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Gender Differences in Attitudes toward and Confidence in Computer Science[1]

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Abstract

We examined gender and student group differences in stereotypes and confidence in Computer Science (CS) in first-year and CS students. First-year students' attitudes towards CS were more stereotypical than CS students'. There was no gender difference in computer confidence for first-year students, but females in CS had significantly lower confidence than did males.

This nation faces a serious shortage of computer scientists. From 1986 to 1996, the number of men majoring in Computer Science (CS) dropped by 33%, whereas the number of women dropped by 55% (calculated from data in U.S. Department of Education, 2000). This shortage of computer scientists provides a major impetus for increasing the representation of women in CS. Two reasons for the small number of women in CS are negative attitudes towards the field and low confidence. Beyer (1990, 1998, 1999b, 2002; Beyer & Bowden, 1997) has repeatedly found that females have inaccurately low confidence in masculine domains.

CS is stereotyped as even more male-dominated than the traditional male bastions of chemistry and mathematics (Beyer, 1999a). Both males and females *incorrectly* believe that males in CS have higher GPAs than females (Beyer, 1999a). Furthermore, those women who do succeed in CS are often viewed as "exceptional", leaving the stereotype that women do not belong in CS intact (Henwood, 1999/2000).

The stereotypes about CS majors are unflattering. They are perceived to be intelligent but deficient in interpersonal skills (Beyer, 1999a). This has been termed the "computer nerd syndrome" or "geek mythology" (Margolis & Fisher, 1997; Rasmussen & Hapnes, 1991). These perceptions of CS majors conflict more with the gender roles of females than of males, because women tend to have a stronger interpersonal orientation than men (Cross & Madson, 1997; Markus & Kitayama, 1991).

The major goal of the present research is to discover the barriers that discourage undergraduate women from taking courses in CS. To this end we examine gender and student group differences in attitudes and confidence in CS in first-year students and more advanced students taking a CS course.

Method

In the spring of 2001 we distributed 18-page questionnaires to 30 first-year students (21 females, 9 males) and 32 students enrolled in an introductory CS course (11 females, 21 males) designed for students seriously considering majoring in CS. Unless otherwise noted, questions were of our own design.

Participants filled out questionnaires assessing demographic and family background information; ability and preparation in quantitative areas; educational goals and interests (Farmer, Wardrop, Anderson,& Risinger, 1995; Lips, 1992); experience with and attitudes towards computers (Lips, 1992); stereotypes and knowledge about CS; confidence (Nickell & Pinto, 1986); interpersonal relations (Cross, Bacon, & Morris, 2000; Cutrona & Russell, 1984); family orientation (Ethington & Wolfle, 1988); personality attributes (e.g., self-esteem [Rosenberg, 1965], gender roles [Bem, 1974], and the Big 5 [John & Robins, 1993]); stress (Cohen, Kamarck,& Mermelstein, 1983); financial and family issues; support and encouragement; gender discrimination; and academic environment. In addition, participants' course-taking behavior, CS attitudes, and confidence are being followed for three years.

Results

2 (gender) x 2 (student group: first-year students vs. CS students) analyses of variance (ANOVAs) were calculated.

Demographic variables. As expected, CS

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students were significantly older (24.7 years) than first-year students (21.5 years), $F(1, 55) = 4.14, p < .05$, and more advanced in their university career, $F(1, 55) = 132.81, p < .0001$. Male and female students were remarkably similar in terms of demographic variables including age, race, number of siblings, year in college, marital status, number of children, prevalence of disabilities, socioeconomic status while growing up, and parental level of education. The significant interaction between gender and student group indicates that for CS, females were less likely to be full-time students than were males, but no difference existed for first-year students, $F(1, 53) = 6.08, p < .02$.

Ability and preparation in quantitative areas. First year students' ACT test scores were significantly lower than CS students' in Math, $F(1, 29) = 5.45, p < .03$, and Geometry, $F(1, 25) = 4.56, p < .05$. They also had lower math placement test scores, $F(1, 36) = 7.42, p < .01$. CS students reported significantly higher GPAs in high school, $F(1, 49) = 5.12, p < .03$, and college than did first-year students, $F(1, 41) = 8.84, p < .005$.

The only significant gender difference in actual ability and preparation variables was for placement test scores in math with males scoring significantly higher, $F(1, 36) = 6.28, p < .02$.

Educational goals and interests. There were no gender or student group differences in the level of education participants aspired to completing. CS students reported spending significantly more time on school work (25 hours) than did first-year students (10 hours), $F(1, 53) = 19.85, p < .0001$. First-year students were significantly more people-oriented in their career selections than were CS students, $F(1, 55) = 5.14, p < .03$. For CS students, opportunities to use their abilities were more important in their career selection than they were for first-year students, $F(1, 55) = 4.02, p < .05$.

Previous experience with and attitude towards computers. There were no gender or student group differences regarding the age at first computer use. About 97% of CS students reported owning a computer compared to 71% of first-year students $F(1, 55) = 8.37, p < .005$. The average CS student spent 35.5 hours a week on a computer compared to 10.3 hours for first-year students, $F(1, 55) = 29.63, p < .0001$.

There was a significant interaction between student group and gender in programming experience, $F(1, 53) = 4.22, p < .05$. Whereas no difference in programming experience existed for CS students, male first-year students had more programming experience than females. Not surprisingly, CS students had more programming experience (97%) than did first-year students (37%), $F(1, 54) = 28.00, p < .0001$.

The two variables that showed the largest gender difference in experience with computers relate to questions about having taken a computer apart, $F(1, 55) = 9.35, p < .003$, and having installed internal components such as RAM into a computer, $F(1, 55) = 11.65, p < .001$, with males having more experience. CS students have more experience in taking a computer apart, $F(1, 55) = 8.56, p < .005$, and in installing internal components, $F(1, 55) = 6.27, p < .02$, than do first-year students.

Stereotypes and knowledge about CS. First-year students' responses to what the typical CS student is like were more stereotypical than were CS students'. First-year students were significantly more likely to describe CS students as uninteresting and asocial, $F(1, 55) = 17.22, p < .0001$. The only gender difference was that males were more likely to believe that CS majors enjoy games like chess than were females, $F(1, 53) = 5.53, p < .03$.

There was no gender difference in knowledge of what CS is. However, CS students had significantly more accurate knowledge of CS than did first-year students, $F(1, 53) = 6.51, p < .02$. Both males and females rated the career opportunities of students with CS degrees as excellent.

Whereas only 25% of first-year students knew someone with a CS degree, 44% of CS students knew someone with a CS degree before taking a CS class. This suggests that knowing a computer scientist may increase the likelihood of taking a CS class.

First-year students thought that there are significantly more women in CS (30.3%) than CS students thought (20.5%), $F(1, 54) = 8.29, p < .006$. First-year students also thought that CS majors have higher GPAs (3.5) than CS students did (3.0), $F(1, 54) = 23.99, p < .001$.

We asked questions regarding CS as a career for parents of young children. Participants indicated that it would be a good career because of high income and the ability to work from home, but simultaneously thought the high number of working hours and stress would be difficult for parents of young children. Participants did not view CS as a field where success and raising a family are incompatible goals. An interesting gender difference revealed that females more than males valued CS as a career choice of parents due to the high pay, $F(1, 51) = 4.65, p < .04$.

Confidence. A gender difference regarding confidence in computer ability emerged. Whereas first-year males and females had equally high computer

confidence, females in CS showed significantly lower confidence than did males, $F(1, 30) = 4.82$, $p < .04$. This gender difference was not due to differences in ability (math grades and ACT scores were controlled).

Personality variables. There were no gender or student group differences in interdependent self-construal, self-esteem, family orientation, or conscientiousness. However, first-year students scored significantly higher in neuroticism, $F(1, 51) = 17.69$, $p < .0001$, and openness to new experiences, $F(1, 51) = 12.48$, $p < .001$, than did CS students. CS students were more likely to score as masculine (57%) on the Bem Sex Role Inventory (Bem, 1974) than first-year students (25%), $F(1, 55) = 3.87$, $p < .06$. Conversely, first-year students scored higher on femininity than did CS students, $F(1, 55) = 5.81$, $p < .02$. CS students also scored higher than first-year students on interpersonal scales measuring social integration, $F(1, 55) = 5.05$, $p < .03$. It is noteworthy that no gender differences in any of the personality variables emerged.

Stress and financial issues. There was a significant interaction between gender and student group for stress, $F(1, 54) = 4.03$, $p < .05$. It reveals that first-year females reported experiencing significantly more stress than did first-year males, $F(1, 28) = 6.29$, $p < .02$, whereas no gender difference in stress emerged for CS students. There were no differences in employment status, hours of outside employment, or financial responsibilities. CS students were significantly more certain of having adequate financial support to finish college than were first-year students, $F(1, 55) = 11.62$, $p < .001$.

Discussion

This research found negative stereotypes regarding CS, especially among first-year students who described the typical CS major as uninteresting and asocial. It is unclear whether the attitudes of CS students were less stereotypical to begin with, increasing their likelihood of taking a CS class, or whether taking a CS class changed their attitudes in a less stereotypical direction. The longitudinal design of this research will eventually address this issue.

The stereotypes of CS majors as "nerds", their perceived obsession with machines and lack of interest in people, and associations of technology with masculinity conflict with the gender roles of females (Cross & Madson, 1997; Markus & Kitayama, 1991). Coupled with the stereotypical but inaccurate perception of women's lower ability in CS (Beyer, 1999a), these stereotypes probably conspire to deter women from CS.

The gender difference in computer confidence among CS students is of concern. It may lead to greater attrition of women. The low confidence among females in CS is not due to a lack of ability. Males and females perform equally well in computer programming courses (Armstrong, LeBold, & Linden, 1986). In fact, women students majoring in CS have higher GPAs than males (Beyer, 1999a; NSF, 1996). Our longitudinal research is currently investigating the cause of this drop in females' computer confidence. Interestingly, no gender difference in confidence was found for first-year students.

One cause of women's low confidence is their less playful and relaxed attitude towards computers (Rasmussen & Hapnes, 1991). This is exemplified in this study by men's greater likelihood to have taken a computer apart. Confidence is also affected by the amount of previous experience with computers (Zubrow, 1987). Women tend to have less computer experience than men (Aman, 1992; Zubrow, 1987), which negatively affects their confidence. However, in this study no gender difference in computer experience was found for the CS students.

What is the consequence of this low confidence? Positive self-perceptions of ability are intimately tied to aspirations, educational choices, preference for challenging tasks, intrinsic motivation, persistence, and thus have desirable effects on performance (for a review see Beyer, 1995). Indeed, high performance expectations are a better predictor of mathematics participation and of continued high confidence for the future than are grades (Beyer, 1999b; Lantz & Smith, 1981). Positive self-perceptions of ability are related to self-esteem and psychological health, whereas negative self-evaluations of ability are related to depression (see Beyer, 2002, for an overview). This suggests that females' low confidence has deleterious affective and behavioral consequences. Importantly, low confidence may decrease the likelihood that women will choose to major in CS and may negatively affect their retention in the field.

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